Space Weather Technical Forecast

Issued on Friday, 03 March 2023 at 01:21 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Likelihood of M-class flares, with slight chance of X-flares. Isolated G1/Minor Storms intervals likely days 3 and 4. Active fluence declining.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate, with a M8.4 flare peaking at 02/2115 UTC from AR3234. This region remains the largest and most complex region on the disc, with one delta spot apparently remaining, although analysis is becoming harder as the region approaches the northwest limb. There are five other numbered sunspot regions on the visible disc, plus three unnumbered regions, and most are small, weak, magnetically simple and are either stable or slowly decaying. However, one new region near the northeast limb is currently the second largest and may prove to have a complex magnetic structure once foreshortening effects recede as the region rotates further onto the visible disc.

A filament eruption occurred in the afternoon, starting around 02/1630 UTC and this generated a Coronal Mass Ejection (CME), which is currently thought unlikely to be Earth directed. The M-class flare also produced a CME, which has slightly more potential to be Earth directed. Analysis will be undertaken of both CME's once coronagraph imagery becomes available.

Solar Wind / Geomagnetic Activity: The solar wind as observed at L1 by DSCOVR and ACE, was at slightly elevated to elevated levels, generally between 460-530 km/s, peaking at 561 km/s at 02/0133 UTC.. Density was below average initially, then increased to mainly average to above average levels. Total IMF, Bt, was weak at 7nT or below, then strengthened to become moderate through the afternoon and most of the evening, peaking at 11 nT at 02/2114 UTC. The north-south component, Bz, fluctuated weakly but then became generally weakly negative from late afternoon. The phi angle was predominantly negative (towards the Sun), although was variable initially. The solar wind environment was indicative of initially waning High Speed Stream (HSS) effects from CH79, with weak CIR and then subsequent weak connection to a HSS from CH81 occurring through the afternoon and evening. Geomagnetic activity was Quiet (Kp 1-2), then increased Active (Kp 4) to end the day.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16 is at background levels. Electron flux was mostly above the High threshold, peaking at 3.77e3pfu at 02/1715 UTC, but sharply fell below the High threshold from 02/2020 UTC. Electron fluence remained above the Active threshold (1e8 integrated flux) throughout, but followed a gradually declining trend with 1.2e8 integrated pfu observed at 03/0000UTC.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected with a slight chance of Strong activity, mainly from AR3234 in the northwest quadrant. However, new regions are expected to rotate on from the far side, potentially increasing the chance of significant flares

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Solar Wind / Geomagnetic Activity: No Earth directed CMEs are currently forecast, although analysis will be undertaken of the two CME's that occurred on the 2nd The previously declining influence of the HSS from coronal hole 79 appears to have been slightly enhanced by a HSS from CH81. From day 3 (5th) a further enhancement from CH81 is expected, and therefore the solar wind is likely to be elevated or strong for much of the period. In addition CH81 has a negative polarity, which is more favoured for geomagnetic response near the March equinox. Geomagnetic activity is expected to be Unsettled to Active (Kp3-4) at first and then generally through days 3 and 4 (5th and 6th) with isolated G1/Minor Storm (Kp 5) intervals likely through Days 3 and 4. Temporary Quiet to Unsettled (kp 2-3) conditions are likely to occur later today and during day 2 (4th).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 2MeV) is at background levels with a slight chance of S1/Minor Storms, mainly from AR3234. Electron flux is expected to return above the High level later today and again at times tomorrow, before likely declining later in the period as geomagnetic activity increases. Electron fluence is currently above the Active (1e8 integrated pfu) level, and is expected to temporarily decrease below the Active level for a time today before rising above again later today and through tomorrow. Later in the period fluence levels may decrease below the Active threshold.

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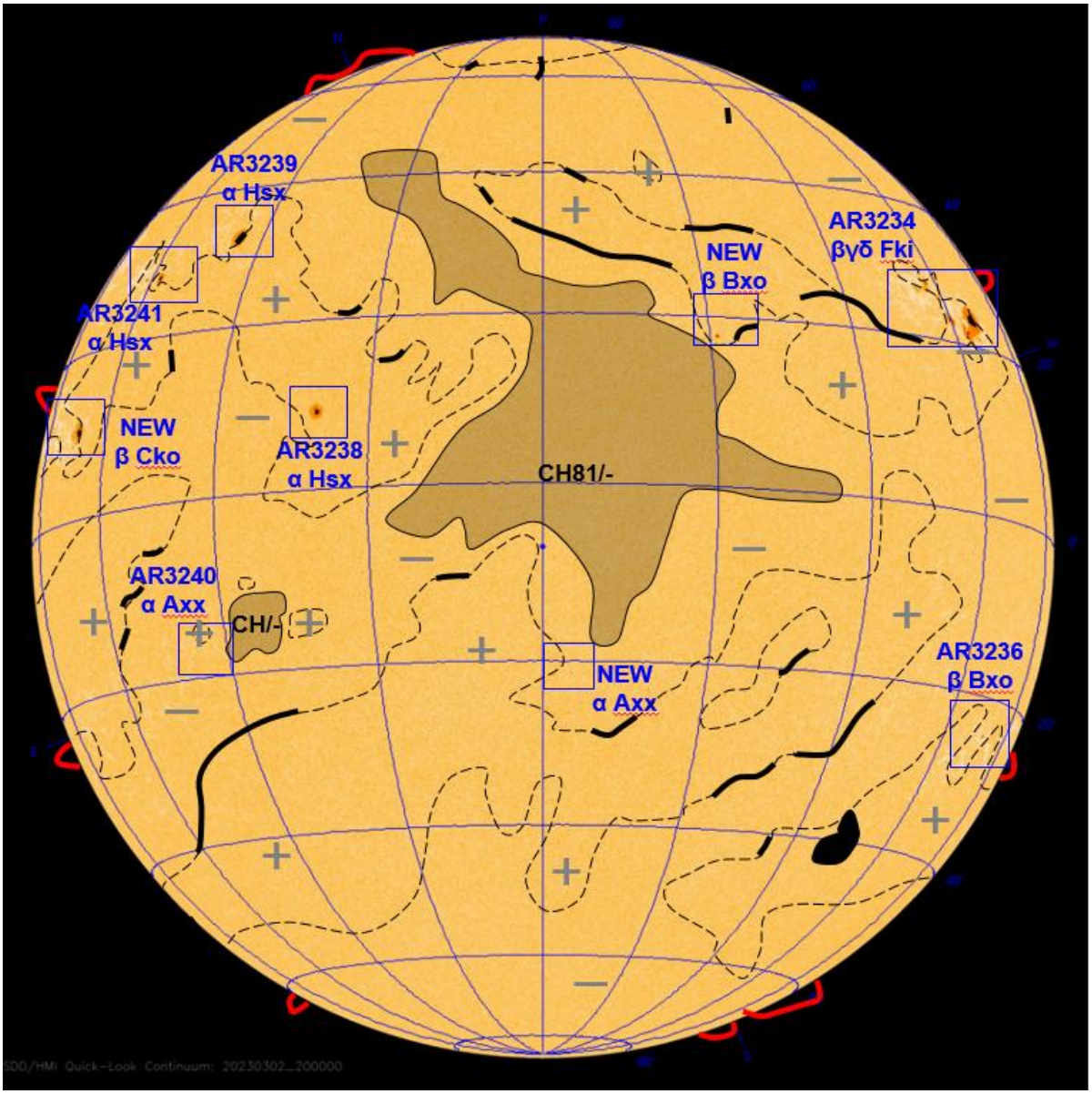
Figure 1. Solar Analysis Valid 02/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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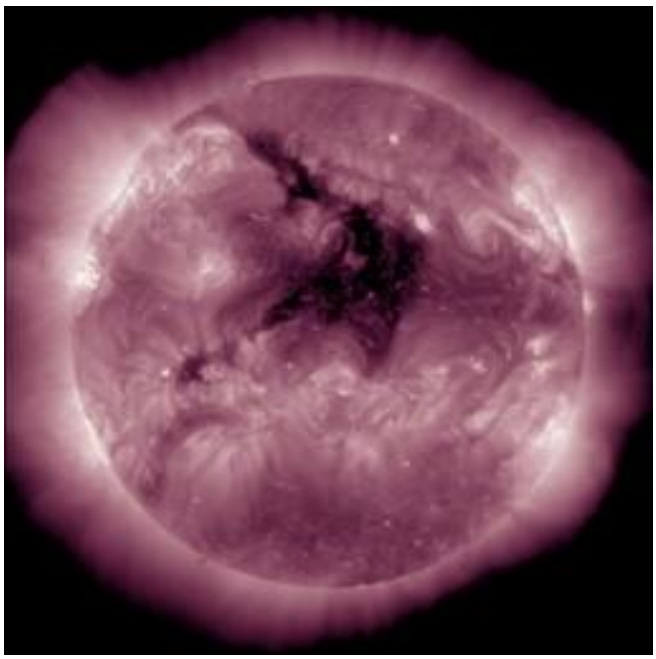
Geomagnetic Storms:

No Earth directed CMEs are currently forecast, although analysis will be undertaken of the two CME's that occurred on the 2nd, with the CME associated with the M-class flare most likely to have an Earth directed element.
The previously declining influence of the HSS from coronal hole 79 appears to have been slightly enhanced by a HSS from CH81. However, this initial influence of CH81 is likely to remain weak today and tomorrow, due to the diffuse and weak nature of the leading part of the coronal hole. From day 3 (5th) a further enhancement from CH81 is expected, as Earth connects to the more substantial body of CH81. Wind speeds are likely to be elevated or strong for much of the time, potentially reaching 600-650 km/s as the strongest portion of the HSS from CH81 arrives later in the period. In addition CH81 has a negative polarity, which is more favoured for geomagnetic response near the March equinox.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	20	50	50
Strong	G3	No	1	1	5	5
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: Latest SDO AIA/211 image showing CH81, the main portion of which Earth is yet to connect to.



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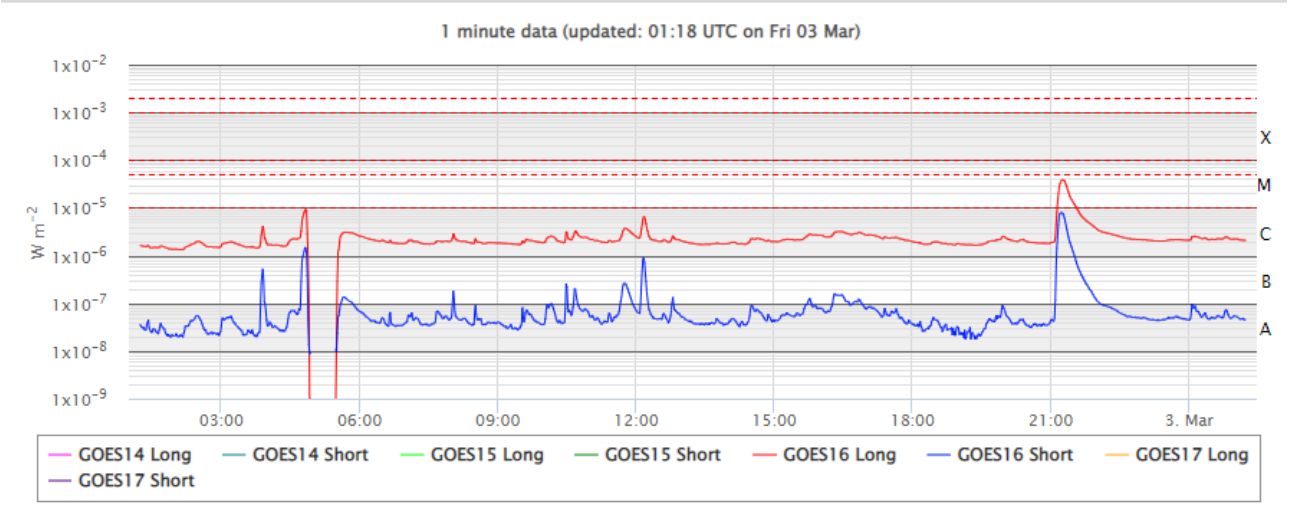
Radio Blackouts - X-Ray Flares:

AR3234 appears to have weakened and simplified slightly, becoming less compact and with only one delta spot now potentially present. This region will rotate behind the west limb during day 3 (5th). The remaining five numbered sunspot regions currently on the disc are all small, weak and magnetically simple, and are either stable or weakly decaying. There are three further unnumbered regions on the disc, with one near the east limb apparently the second largest and most complex on the disc. Far side seismographs suggest that further regions are likely to rotate on in the coming days, and these may further increase the chance of significant flares.
Solar activity is expected to be mainly Low to Moderate, with a slight chance of Strong activity, this most likely from AR3234.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	50	50	40	10
Very Active	R3 to R5 X Class	No	15	15	10	1

Figure 3: GOES-16 x-ray flux with the M-class flare from AR3234.



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Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux, as observed by GOES16, is at background levels. Although no significant flares have been observed recently, the position and complexity of AR3234 presents a risk of proton rich flares, with a continuing slight chance of S1

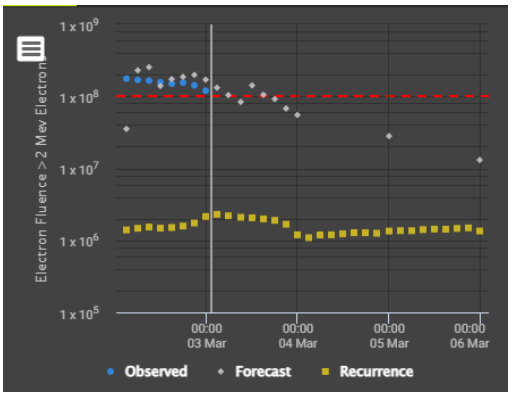
Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

Electron flux is expected to return above the High level later today and again at times tomorrow, before likely declining later in the period as geomagnetic activity increases. Electron fluence is currently above the Active (1e8 integrated pfu) level, and is expected to temporarily decrease below the Active level for a time today before rising above again later today and through tomorrow. Later in the period fluence levels may decrease below the Active threshold.
MOSWOC REFM is suggesting an overall gradual decline below Active, which is not unreasonable, although confidence is only moderate in the timing of this.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	70	50	50
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	10	10	10	5

Figure 4: Met Office REFM model.



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